B I D D I N G D O C U M E N T

for

The Work of Design, Engineering, Construction and Commissioning 10 MLD Sewage Treatment Plantwith Biological Nutrient Removal (BNR) at Anjanapura-2 BDA layoutwith 10 MLD TSPS, Pumping Main and Operation & Maintenance for Seven Years.
(DBO contract)

Contract Package –
BWSSB - ANJ-2 - BDA

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PART 12

PARTICULAR ELECTRICAL PLANT REQUIREMENTS

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PART12

PARTICULAR ELECTRICAL PLANT REQUIREMENTS

12.1 Introduction

The specific design and performance requirements for all electrical equipment are given in this part of the Specifications. The Requirement specified shall be fully met with by the Contractor. In case of any deviations, the Contractor shall bring out the same in "Schedule of Deviations from Particular Requirement" failing which shall be considered that the Contractor fully complies with these requirements.

12.2 Scope of works

The scope of worksfor STP/TSPS includes design, manufacture, testing at works, supply and delivery at site, unloading and storing the equipment at site of installation,installation,testing and commissioning of the following equipment at site

11kV Metal enclosed Switchboards,11kV/0.433kV transformers, 415V Diesel Generator Sets with Acoustic Enclosure& AMF Panel, 415V Metal enclosed switchboards/distribution boards/motor control centres, 415V capacitor banks with APFCR panel, Battery,Battery charger,DC Distribution board, Variable Frequency drives,Non segregated bus ducts, Lighting system,Power &control cables, Cable carrier system, Earthing & Lightning protection system.

All equipment/items shall be of makes as specified in the list of preferred makes.Various equipment/ items shall conform to latest applicable standards specified. In case of Conflict between standards and this specification, this specification shall govern.

12.3 Primary Power Source

i. STP: Anjanapura

Electrical power supply for respective STP/TSPS, and LPSs shall be derived at 11kV, 3Phase, 50Hz from the nearest BESCOM's substation. BESCOM shall making necessary modifications in their substation by adding extra 11kV switchgear/Breaker, laying 11kV overhead line/underground cable up to the double pole structure in new STP/TSPS location.

Necessary double pole structure, lightning arrestors,11kV Isolators, CTs, PTs, interconnecting cable from double pole structure to metering unit, metering unit and VCB shall be provided by BESCOM. This work shall be executed by BESCOM and amount needs to be paid to BESCOM through provisional sum for executing the above works. The Contractor's scope includes liasoning with BESCOM for getting construction power supply, making new power supply agreement for the plant and getting final clearance from CEIG for complete Electrical system.

The Contractor's scope for STP/TSPS and starts from the outgoing of corresponding 11kV VCB provided by BESCOM near two pole structure and shall cover all equipment/items as given above in clause 12.2, Scope of works.

12.4 Power supply arrangement

The Incoming 11kV (overhead line / underground cable)supply fromBESCOM shall be terminated at outdoor two pole structure. Outgoing terminals of the twopole structure shall be connected further to outdoor 11kV metering unit to be located near two pole structure. The outgoing cable from the metering

unit shall be connected to incomer of 11kV Metal Enclosed Switchboard at STP/TSPS. The outgoings of the 11kV Metal Enclosed Switchboard shall feed two numbers 11/0.433kV Distribution Transformers. The two numbers 11/0.433kV Distribution Transformers shall feed total working load of STP/TSPS.

12.5 General Design Criteria for STP/TSPS

All electrical equipment shall be rated for 45°C design ambient temperature. The installation shall generally conform to Indian Standards / IEC.

The following factors shall be considered for proper selection of electrical apparatus or equipment for areas where flammable gas or vapours may rise.

(a) Area classification

The classification of area shall be as per IS 5571 & IS 5572, based on the degree of probability with which explosive concentrations of combustible gas or vapour may arise in installations in terms of both the frequency of occurrence and probable duration of existence on each occasion.

(i) Zone 0 – In which an explosive gas/air mixture is continuously present or present for long periods.

(ii) Zone 1 – In which an explosive gas/air mixture is likely to occur in normal operation.

(iii) Zone 2 – In which an explosive gas/air mixture is not likely to occur in normal operation and if it occurs, it shall exist only for short periods.

(b) Gas Group Classification

The characteristics of the gas or vapour involved in relation to Igniting current or minimum ignition energy in case of installations of intrinsically safe apparatus or maximum experimental safe gap data in case of installations for flame proof enclosures as per IS 2148.

(c) Temperature Classification

The Ignition temperature of the gas or vapour involved, or the lowest value of ignition temperature if more than one combustible material shall be present.

The maximum temperature of any unprotected surface of electrical equipment shall not exceed the Ignition temperature of gas or vapour. For electrical apparatus, no margin of safety need be applied between maximum surface temperature and ignition temperature. The Ignition temperature of combustible gases and vapours are measured in accordance with the test method prescribed in IS 7820.

(d) **Environmental conditions** in which the apparatus shall be installed. Apparatus and its component parts shall be constructed so as to guard against electrical and mechanical failures in the intended conditions of use.

The selection of type of protection of electrical equipment for the different zones of Hazardous areas shall be made in accordance to Clause 6, Table -1 of IS 5571.

All electrical equipmentinstalled in hazardous areas shall confirm to selection of equipment and installation guidelines of IS 5571.

12.6 HVSystem

a) Nominal voltage : 11kV
b) Number of phases : 3
c) Frequency : 50 Hz
d) Connection : 3 Wire
e) Maximum Fault Level/current : 500MVA(26.25kA)

12.7 LV System

(a) General Supply

a) Voltage: :415 V nominal
b) Frequency: : 50 Hz
c) Connection : 4 wire
d) No load transformer voltage : 433 V
e) System earthing : Solidly earthed
f) Maximum fault level/current : 36 MVA (50kA)

All Plant shall, unless otherwise specified, be capable of continuous operation at a voltage level in the range of 90% to 110% of the relevant nominal voltage and a frequency variation of plus 5% minus5%with a maximum combined tolerance of 10%.

(b) AC Control,Lighting and Space Heating

- Voltage: 240 V
- Phases: 1
- Frequency 50 Hz
- Connection 2 wire (Phase & Neutral)

(c) DC Control,Protection and Alarm

- Voltage: 110 V
- Phases: 1
- Connection 2 wire (unearthed)

12.8 HV Metal Enclosed Switchboard

12.8.1 11kV Indoor Switchboard

11kV Switchboard shall be indoor, floor standing,sheet metal enclosed with IP4X degree of protection, with draw out type vacuum circuit breakers for incoming & outgoing feeders, control &protection. The switchboard shall be rated for a fault current not less than 26.25 kA (rms). All protective relays shall be numerical type.

12.9 Distribution Transformer

12.9.1 11/0.433kV Transformers

The transformers shall be out door type, ONAN, 11/0.433 kV,3 phase, 50 Hz,two winding, Dyn11 with solidly earthed neutral with OLTC.

The transformers shall be sized considering 20% contingency of total working load while arriving at the final capacity of transformers. Two numbers of transformers shall be provided in each load location such that under normal condition, each transformer shall be loaded up to 50% and in case of failure of any one transformer, the healthy transformer shall have capacity to take entire load so as to have 100% standby.

The transformers shall be designed such that at any point of time maximum loading (including Contingency Capacity) on any single transformer shall not exceed 80% of full load capacity.

12.10 System Protection

Numerical relay-based protection system for various parts of the power supply system shall be proposed. The following protection systems shall be used:

(a) 11 kV Incomer Feeder

- Instantaneous phase overcurrentprotection
- Instantaneous earth fault protection
- Inverse definite minimum time phase over current protection
- Inverse definite minimum time earth fault protection
- Potential transformer fuse failureprotection
- Under voltageprotection
- Negative phase sequence protection
- Breaker failure protection
- Inrush protection

(b) 11 kV Transformer Feeder

- Inverse definite minimum time phase overcurrent protection
- Inverse definite minimum time earth fault protection
- Instantaneous phase over current protection
- Instantaneous earth fault protection
- Standby earth fault Protection
- Thermal overload protection
- Inrush protection
- Breaker failure protection
- Winding temperature high, alarm &trip
- Oil temperature high, alarm &trip
- Buchholz relay alarm and trip
- Magnetic oillevel gauge alarm
- Restricted Earth Fault relay to be provided for Transformer rating 2MVA and above
- Pressure relief valve alarm & trip
- Oil surge relay trip
- Alarm annunciation with connectivity (communication port RS485) to PLC

(c) 415VIncomer Feeder

- Overload, Earth fault and short circuit protection
- Under voltage Protection

(d) LV Motors

(i) Motors less than 15kW

- Motor Protection relay with following protection
- overload protection by three phase thermal (bimetal) relay
- Single phasing preventer
- MotorProtection Circuit Breaker (MPCB)

(ii) Motors 15kW upto75kW

- Electronicmotor protection relay providing the following protection
- Overload
- Earth fault

- phase currents out of balance
- Single phasing preventer
- MCCB

(iii) Motors above 75kW

- Comprehensive motor protection relay providing the following protection
- Thermal Overload
- locked rotor
- Phase Over current (50/51)
- Earth fault(50N/51N)
- Over voltage & under voltage
- phase loss/reversal
- Negative sequence
- Protection for repeated and prolonged starts
- restart inhibition
- Single phasing preventer
- Temperature Monitoring (Alarm & Trip)
- ACB/MCCB

Note: - RTD's of Winding and Bearing Temperatures of Pumps / Motors shall be monitored through Temperature Scanner Indicators.

(iv) Pump Drives

All pumps shall be provided with the following additional protection, as per requirement:

- Dry run protection
- Temperature protection, (Submersible pumps)
- Moisture entry protection. (Submersible pumps)
- Over pressure (positive displacement pumps)

(v) Blowers

Blowers shall be provided with the following additional protection:

- Over pressure

(vi) Rotating Arm Drives

Rotating arm drives shall be provided with the following additional protection:

- motion detectors
- Over torque detectors

(vii) Valve Actuator Drives

Valve actuator drives shall be provided with the following additional protection:

- Over torque detectors

12.11 Switchgear Equipment / Instruments

(a) 11kV Feeders (Incomer andTransformer feeders)

- Ammeterfor all 3 phases
- Voltmeter with selector switch
- KW meter
- KWh meter
- KVARh meter
- Frequency meter

- Power factor meter.
- Digital Multifunction meter with RS 485 connectivityfor measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

(b) 415V Incomer Feeders

- Ammeterwith selector switch
- Voltmeter with selector switch
- KW meter
- Digital Multifunction meter with RS 485 connectivityfor measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

(c) 415V Motor Starter Feeders

- Ammeter with selector switch
- Voltmeter with selector switch
- KW meters for Motor feeders more than 75kW
- Multifunction meters with facility to extract historical data for Process Air Blower Feedersand for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters
- DOL Starters for motorfeeders less than or equal to 5.5kW
- Star-Delta Starters for motor feeders above5.5kW andupto 75kW
- Line/Neutral Soft Starters for motor feeders above75kW

12.12 Standby Diesel Generator Sets

There shall be one number415V, 50Hz Standby Diesel Generator Set with Acoustic Enclosure and AMF panel at STP/TSPS locations. The capacity of theStandby Generator at each location shall be sized for power back up for all critical loadswhich are required for continuous operation of the corresponding STP/TSPSplant during main power failure. Minimum of 50% of total working loads of the entire Plant and 10% Contingency over these loads shall be considered while sizing the DG Set.

12.13 Automatic Main Failure Panel

One AMF (Automatic Main Failure Panel) panel shall be provided for the Diesel Generator Set.

In case of main failure detected by an under-voltage relay mounted in the AMF panel, the main breakers (receiving the main power from BESCOM) shall be switched off under auto mode. Consequently, the standby generator starts in the auto mode. After the generator set reaching the rated speed and rated voltage, the generator circuit breakers shall be switched on to feed Diesel Generator power to the AMF panel. On restored main supply, the reverse sequence of the above shall be followed for the mains supply to feed power to the loads as in normal condition.

The two breakers in the panel shall be operated manually at the AMF panel during trouble shooting or maintenance.

12.14 415V PCC / MCC

415V PCC/MCC shall be floor standing, sheet steel enclosed withIP 54 Degree of Protection, Form–IV enclosure as per IS 8623complete with Air circuit breakers/MCCB’s /MPCBs, Control &Protection. The PCC /MCC shall be rated for a fault current not less than 50kA(rms) for 1 sec.

All Motor Feeders in the MCC Panels shall have Contactors, Start-Stop Pushbuttons, ON-OFF-Trip indicationand OLR reset button. All starter feeder shall have with Type-2 coordination and Contactors have AC3 duty.

12.14.1 Local Control Panel (LCP)

For each motor:

- Local/Off/Remote selector switch to be provided. 3 Push buttons "START / STOP / EMERGENCY STOP" shall be provided.
- Start push button operates only when the switch on LCP is in "Local" position.
- Stop push button shall operate only after pre-determined requirement of closing the delivery valve either in Local mode or Remote mode for 90kW and above pump motors.
- Emergency Stop push button operates irrespective of the position of the selector switch.

When the selector switch on LCP is in "LOCAL" position, the motor shall be operated by push buttons on LCP and shall take into account only the specific fail-safe controls of the equipment (electrical protections, low level for a pump). When the selector switch on LCP is in "REMOTE" position the drive shall be operated from PLC

Motorized valves shall be with fully integrated control Actuator. The actuator comes with integrated:

- One Selector switch "Remote / Local"
- Control switch for: OPEN / CLOSE/ STOP.
- Local Control cubicle with remote operation from PLC with position feedback.

12.14.2 Operation Logic of Switchgears

Operation Logic of 415V Metal Enclosed Switchboard at STP Substation:

- At normal condition, both the Incomers shall be in Closed Position and the DG Incomer & Buscoupler shall be in Open Position.
- If any Incomer fails the faulty Incomer shall be in Open Position, the Buscoupler and the healthy Incomer shall be in Closed Position.
- In Case of Power Failure, DG Incomer & Buscoupler shall be in Closed Position and the Mains Incomer shall be in Open Position. The critical loads of the plant shall run on DG Set.

12.14.3 Capacitor Banks and Power Factor Correction

The LT capacitor banks provided shall be of bus connected type with Automatic Power factor correction, the system shall be designed such that a power factor of not less than 0.98 shall be maintained.

Automatically controlled multistage power factor correction shall be provided. 2 Nos. PFC panels providing no less than 8 number PFC stages per panel shall be provided each connected to one bus section of the LT Switchboard. The PF on each bus section of the board shall be monitored and corresponding PFC capacitors switched in and out automatically in discrete stages to maintain a set point PF value.

Each panel shall be configured such that no PFC capacitor stages shall operate when the standby generator is powering the side of the distribution board to which shall be connected. Reactors shall be provided for the protection of capacitors.

MCCBs,Switches,Contactors shall be suitable for making and braking current of the capacitors. The Panels shall be floor standing, sheet steel enclosed withrelevant degree of Protection.

12.14.4 Variable Frequency Drives

Following minimum loads shall be provided with Variable frequency Drives with communication port:

- TSPS Pumps
- Process Air Blowers
- Mixed Liquor Recycle Pumps
- Return Activated Sludge Pumps
- Centrifuge Feed Pumps
- Dewatering Centrifuges
- Alum Dosing Pumps
- Polymer Dosing Pumps

12.14.5 DC Power Supply

DC Power supply shall be provided for protection and control in 11kVand 415V Switchgears and for DC emergency lighting for Substation Building and the Contractor shall maintain minimum illumination level of 5 lux.

A Conventional system operating at 110V DC using maintenance free rechargeable Ni-Cd batteries shall be provided and shall be complete with battery, battery charger with boost & trickle charging facilities, necessary controls, indications and DC distribution board.

12.15 Cabling

(a) 11kV Power Cables

The cables shall be 3core,11kV (UE),XLPE type with stranded aluminium conductors& GI armouring. Minimum size of cable shall be selected based on the short circuit current considerations.

(b) LV Power Cables

LV power cables shall be 1.1kVXLPE type with stranded Aluminium/Copper Conductorswith GI armouring for the following sizes:

(i) ≤ 6 Sq.mm. - Stranded Copper conductors with GI armouring cable

(ii) > 6 Sq.mm - Stranded Aluminium conductors with GI armouring cable

No. of cores shall be as per requirement.

(c) Control Cables

Control cables shall be 650/1100V, XLPE with stranded copper conductors and GI armouring. No. of cores shall be as per requirement. Minimum size of core shall be 1.5 Sq.mm.

(d) Cable Rating

All power cables shall be sized for continuous current carrying capacity and permissible voltage drop at an ambient temperature of 45 degrees C.Due consideration shall be taken of cable grouping, method of installation and local variations in ambient conditions. Further, for cables controlled by circuit breakers, due consideration shall be given to the fault level.

HV and LV cables shall be sized for a minimum fault clearance time of 1 second for incoming feeders and 0.5second for equipment feeders

For all LT Cables, the voltage drop in the cables between the transformer and the switchgear (PCC) or between PCC and MCC for full load current shall be limited to 2%.Further the voltage drop in cables between PCC/MCC to Motor terminals for full load current shall be limited to 3%. The Total Voltage drop transformer secondary to motor terminal shall be limited to 5%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energisation.

(e) Cable Installations

Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. These shall be used to route cables along walls,below beams and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made while sizing the cables.

Cables of different categories shall be installed to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cables.

Table of Separation Distances between different Categories of Cable.

Cable Category	HV Power	LV Power	C&I/Protection	Telecomm
HV Power	N/A	300	500	500
LV Power	300	N/A	300	300
C&I/Protection	500	300	N/A	100
Telecomm	500	300	100	N/A

(f) Cable Numbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Cables of different categories shall be tagged with the following subscripts and a three-digit number.

- HV power HV-P_ _ _
- LV power P_ _ _
- Control C_ _ _
- Instrumentation I_ _ _
- Protection PR_ _ _
- Telecommunication T_ _ _

12.16 Building Services

(a) Lighting

All internal and external areas shall be provided with lighting. The illumination levels to be achieved shall be as follows:

Illumination System

Latest version of related IS standards, NBC and National Lighting Code (NLC) shall be referred for designing Illumination for different areas.

All lighting design shall be carried out on Dialux latest version or OEM specific software.

The basis of design shall be based on the following lighting engineering criteria, as per relevant standards or specified herewith:

a) Lighting lux level
b) Luminance distribution
c) Glare restriction
d) Direction of incidence of light and shadow effect
e) Colour appearance and colour rendering of the light source
f) Uniformity

Selection of Luminaries and Illumination Level: The following luminaries shall be provided for various areas in order to achieve the average luminance as per various relevant lighting standards or those indicated below:

Sl. No.	Area	Type of Light Fittings	Lux
1	Pump house	Surface Mounted LED batten	200 Lux
2	Battery room	Industrial type LED batten	150 Lux
3	Machinery service area	Industrial type LED batten	200 Lux
4	Offices and conference rooms	LED Surface mounted decorative down lighter fitting with polycarbonate cover	300 Lux
5	Switchgear room/MCC, DG room	Industrial type LED batten	200 Lux
6	Control rooms/ SCADA room	LED Surface mounted decorative down lighter fitting with polycarbonate cover	300 Lux
7	Chemical and general stores	Industrial type LED batten	150 Lux
8	Chemical plant room	Anti-corrosion Industrial LED batten	200 Lux
9	Cable basement	Industrial type LED batten	100 Lux
10	All other indoor areas	Industrial type LED batten	100 Lux
11	Outdoor platforms and walk ways	LED Bollard post tops and Uplighter	50 Lux
12	Building entrance	LED Surface mounted decorative down lighter fitting with polycarbonate cover	100 Lux
13	Outdoor plant areas	LED Flood lights	20 Lux
14	Outdoor transformer yards - General - On equipment	Industrial type LED batten	 20Lux 30 Lux
15	Roads (secondary)	Industrial type LED batten	20Lux

Ceiling fans shall be provided in offices, control rooms and they shall be connected to local lighting circuit.

The internal lighting installation shall be installed using single core, XLPE insulated copper cable enclosed in galvanized iron conduit. Lighting in external areas shall be installed using multicore armoured cable

Following factors shall be considered while arriving at the utilization factor to determine the number of fixtures for each area/building:

a) Maintenance Factor
   - Indoor Area Lighting with LED Luminaire : 0.7
   - Outdoor Area Lighting with LED Luminaire : 0.6

b) Reflection factor for Indoor Lighting to be considered are as follows:
   - Ceiling : 0.5
   - Walls : 0.3
   - Floors : 0.1

c) However, Reflection factor can be selected based on the Color of the wall and Ceiling as given below:
   - White and very light colors : 0.7
   - Light colors : 0.5
   - Middle tints : 0.3
   - Dark colors : 0.1

d) Room index at applicable surface reflection factors need to be considered.
e) The working plane shall be considered at 0.75 m from the floor level.
f) Uniformity factor shall be considered as per National Lighting code/ NBC/ IS code.

The power supply for lighting shall be distributed from Lighting Distribution Boards and feeder pillars.

For street lighting, cabling shall be done with 4C armoured cable such that alternate fixtures are different phases.

Street lighting shall be Centralized, on grid solar power supply system suitable for power supply to required number of street lights to illuminate the complete treatment facility. Necessary interlocks shall be provided between main supply and solar supplyin such way that solar energy shall be used always and switchover to EB source automatically, when there shall be no solar energy available.

- Solar module shall convert solar energy into electricalenergy and store into the battery. During the night time stored energy shall be converted to AC using efficient inverter and shall be supplied to the street lights. The system shall be powered from the normal grid supply in case of cloudy days or in case of insufficient day light to charge the battery.Roof of "**ADMIN BUILDING"**of STP area can be used for solar cell.

(b) Emergency Lighting

Self-contained chargeable type emergency luminaires shall be provided in all internal premisesexcept Substation building and the Contractor shall maintain minimum illumination level of 5 lux. These luminaires shall automatically illuminate in the event of a power failure and provide a minimum level of lighting for approximately 3 hours. They shall automatically recharge on the return of mains power.

(c) Ventilation & Exhaust Fans (3 phase)

Variable speed ventilation ceiling fans & exhaust fans shall be provided in offices and switchgear rooms as per requirement. One Ceiling fan of 48" size shall be provided for each 10 m^2 or part thereof of the area concerned.

Where fitted ceiling fans shall be connected to the local lighting circuit.

(d) Small Power Outlets

Switched single phase three pin 5 A and 15A receptacles shall be provided throughout. In offices and control rooms they shall be modular decorative type and industrial type in all other areas for single and three phase sockets. All outlets for domestic pump, dewatering pump, submersible sump pump shall be provided with local starter panel or control cubicle. All metal clad sockets shall be provided with suitable metal clad plug.

Unless required to be provided in greater numbers to power specific Plant items the number of such outlets shall be as follows:

- 5 A type one outlet per 5 m or part thereof of perimeter in offices and laboratories
- 5 A type one outlet per 20 m or part thereof of perimeter in all other areas
- 15 A type one outlet per 20 m or part thereof of perimeter in offices and laboratories
- 15 A type one outlet per 20 m or part thereof of perimeter in all other areas.

(e) 3-Phase Power Outlets

32A switched (MCB) three phase and neutral receptacles shall be provided in plant areas where appropriate i.e. adjacent to areas where flooding is likely (to permit the use of portable sump pumps) or where other portable equipment is likely to be used in the operation of the treatment plant.The Contractor shall install ten such outlets at various locations throughout the treatment plant.

The location of outlets shall be approved by the Engineer. The spacing of 5A and 15A outlets shall be arranged to suit the intended location of equipment, desks etc.

Receptacles for outside areas shall have a degree of protection of IP 65.

12.17 System Earthing

An earthing system comprising earth electrodes and conductors shall be established for Sewage Treatment Plant.

The earthing system shall be designed to give a combined earth resistance value of not greater than 1 ohm. In order to be sure of obtaining suitable final values, soil resistivity shall be measured at the various sites during the detailed design phase of the work.

In outdoor substation areas the main earth electrode conductors shall be located, to ensure potential gradients occurring at the surface during fault conditions are kept within allowable limits.

Materials used for earth electrodes shall be designed to suit the ground conditions and shall either be plain mild steel or Galvanised steel.

The system shall be designed for the following maximum earth fault currents. These values shall be confirmed at the detailed design phase.

- **11kV system 26.25 kA.**

- **415V system 50 kA.**

The fault clearing time shall be taken as **three seconds** for the 11kV and415V systems.

The maximum temperature allowed for steel welded joints shall be taken as 500 degrees C with an ambient of 45^{o} C.Main equipotential bonding conductors shall be galvanised steel.

Circuit protective conductors shall comprise either the armouring of the supply cable or, for major loads such as main switchboards and large drives the supply cabling plus an additional suitably sized single core copper cable.

All earthing pits shall be of treated pits only.

Transformer and DG Set neutral earthing shall be of copper earthing.

The neutral point of the 11/0.433 kVtransformer secondary windings shall be solidly earthed.

12.18 Qualification Criteria for Electrical agency/vendor for Design, Supply, Program, Execution and Commissioning of Electrical Works

The contractor shall submit the following documentation as part of credentials submissions for the electrical works for design, supply, and program, execute and commission the electrical works.

The agency which shall design, supply, program ,execute and commission electrical equipment system (HT& LT) on a minimum, shall be operating under an accredited ISO 9001:2015 system and shall be a Class-A electrical contractor with state PWD or central PWD,with a minimum of 10 years' experience of having designed, executed & completed complete electrical systems for STP's, inclusive of supply, installation and commissioning; on a single facility within India during the last five years and shall demonstrate capability and resources for integrating/interfacing with control systems from different manufacturers as well as coordination with multiple agencies for contract execution.

The agency shall demonstrate in house FAT facility with FAT simulation panel and other required hardware and software to conduct FAT as required under this contract. Agency shall submit documentation to validate the same as part of credentials submission.

The Agency on a minimum, shall have executed & completed at least ten individual STP contracts of minimum 25 MLD capacity for electrical system as required under this contract within India, during the last ten years period. Verification end user performance certificates shall be submitted for the same.
Note: In the event, if the OEM intends to execute (design, supply, program, execute and commission) the works, the OEM shall comply in full to the qualification criteria as required in this clause & specification.

The agency shall have an Electrical manager with minimum fifteen years of relevant experience and at least two team leaders with minimum seven years of relevant experience. The agency shall have minimum five number of design engineers with at least three years of relevant experience in design, installation and Commissioning of works similar to this contract and overall capacity and process. The engineers shall be on its permanent employment. Proof of ESIC/PF should be submitted to demonstrate

the permanent employment. (Associate Employer Representatives/ Advisers/ consultants shall not be considered).The agency shall submit documentation and signed resumes of the personnel as part of credentials submission. The contractor and agency shall depute only approved personnel, who's resume has been approved.

12.19 HT Metal Enclosed Switchboard

Sr. No.	Description	Unit	Technical Particulars
12.19.1	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
12.19.2	Type		As per Specification
12.19.3	Applicable Standards		As per Specification
12.19.4	Quantity	No.	(*)
12.19.5	**Switchgear cubicles and Bus bar ratings**		
(a)	Rated voltage, phases and frequency		11kV,3 phase, 50 Hz
(b)	System Neutral Earthing		Resistance earthed
(c)	Maximum system voltage	kV	12
(d)	One-minute power frequency withstand voltage	kV (rms)	28
(e)	12/50 μsec impulse withstand voltage	kV(peak)	75
(f)	Short circuit withstand		
	(i) Short time (1 sec) at rated voltage	kA(rms)	26.25
	(ii) Dynamic rating	kA(peak)	65
(g)	Reference ambient temperature		45°C
(h)	Maximum temperature of bus bars droppers' connectors and contacts at continuous current rating under site reference ambient temperature		Joints, Silver faced : 100°C Busbars and other joints: 85° C
(i)	Continuous current rating of bus bar	A	(*)
(j)	Bus bar material		Copper
(k)	Bus bar Insulation		Fully insulated by encapsulation in epoxy resin with mould caps protecting all joints
(l)	Cable entry		Bottom
(m)	Cable type for Incoming and Outgoing feeders		11kV (UE), XLPE Aluminium conductor with GI armouring
12.19.6	**Switchgear constructional Requirement**		

Sr. No.	Description		Unit	Technical Particulars
(a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partitions		mm	Frame – 2.5min, Doors/Covers/partitions – 2.0min
(b)	Degree of protection			IP4X for panel enclosure & IP52 for metering compartment.
(c)	Colour finish shade			Interior - Glossy white
				Exterior - Light grey semi-glossy shade 631 of IS:5
(d)	Earthing bus	i) Material		Copper (run throughout the panel)
		ii) Size	mm x mm	(*) GS Flat
(e)	Earthing conductor	i) Material		
		ii) Size	mm x mm	(*)
12.19.7	**Breaker Particulars**			
(a)	Circuit breaker type			3 pole,Vacuum draw out type,truck mounted with Surge Suppressor, trip free mechanism & anti pumping feature
(b)	Voltage, phases and frequency			12 kV, 50 Hz, 3 Ph
(c)	Rated operating duty			O –0.3 sec. – CO – 3 min - CO
(d)	Rated current at reference ambient temperature (i) Incoming breakers		A	(*)
	(ii) Outgoing breakers		A	(*)
(e)	Rated breaking capacity		kA (rms)	26.25
(f)	Rated making current		kA (peak)	65
(g)	Short time current withstand for 1 sec duration		kA (rms)	26.25
(h)	Total break time			Less than 50ms
(i)	Operating mechanism type (Normal)			Motor spring Charged stored energy type for closing and tripping
	Operating mechanism type (Emergency)			Manual Spring Charged for closing and tripping
(j)	Minimum no. of auxiliary contacts			6 NO+ 6 NC
(k)	Withstand test voltage			

Sr. No.	Description	Unit	Technical Particulars
	(i) One-minute power frequency	kV (rms)	28 75
	(ii) 1.2/50 μ sec impulse	kV (peak)	
(l)	Auxiliary control voltage (i) For closing / tripping coil		 110 V DC
	(ii) For spring charging motor		240 V AC
	(iii) For space heaters and lighting		240 V AC
	(iv) Permissible variation in operating voltage of closing&tripping coils		85to110% for closing coil 70 to 110% for tripping coil
(m)	Anti-pumping feature		To be provided
(n)	Latching requirement		Trip free
12.19.8	**Current Transformers**		
(a)	Type		Cast resin window type
(b)	Class of insulation		Class E or better
(c)	Rated current ratio and burden (i) Incomers and bus couplers		 (*)
	(ii) Outgoing feeders		(*)
(d)	Accuracy class (i) Metering		 1.0
	(ii) Protection		5P20 and PS for core connected to Restricted Earth fault relay
(e)	Short time 1 sec current rating	kA (rms)	26.25
(f)	Dynamic rating	kA (peak)	65
12.19.9	**Voltage Transformers**		
(a)	Type		Cast resin
(b)	Rated Voltage (i) Primary	 V	 11000/√3
	(ii) Secondary – S1	V	110/√3, 110/√3
(c)	Method of connection (i) Primary – P		 Star, earthed
	(ii) Secondary – S1		Star, earthed
(d)	Application – S1		Metering and protection
(e)	Rated burden	VA	(*)
(f)	Accuracy class		Metering 1.0
			Protection 3P
(g)	Rated voltage factor (i) Continuous		 1.1
	(ii) Short time		1.5
(h)	Insulation class		Class E or better
12.19.10 (a)	**Meters** Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Accuracy Class		

Sr. No.	Description	Unit	Technical Particulars
	(i) Indicating Meters		Class 1.0
	(ii) Energy Meter		Class 1.0
12.19.11	**Protective Relays**		
	Type		Numerical Type
	Auxiliary supply		110V DC
12.19.12	**Annunciations**		
12.19.12.1	**Annunciationsfor Metal enclosed Switch board**		
(a)	Following alarm annunciation shall be provided on the 11kVMetal Enclosed Switchboard Incoming feeders (i) Tripped on fault (ii) O/C&E/F operated (iii) Trip circuit supervision unhealthy (iv) DC fail (v) AC fail		
(b)	For each Outgoing transformer feeder circuit breakers (i) Tripped on fault (ii) O/C&E/F operated (iii) Buchholz, WTI,OTI trip (iv) Trip circuit supervision unhealthy (vi) DC fail (v) AC fail (vi) Buchholz,WTI, OTI,Oil level low alarms		
(c)	For Other Outgoing feeders (i) Tripped on fault (ii) O/C&E/F operated (iii) Trip circuit supervision unhealthy (iv) DC fail (v) AC fail		
(d)	For Bus PT (i) Under voltage trip (ii) DC fail (iii) AC fail		
(e)	Spare windows : 2 Nos. Min.		
12.19.13	**Cubicle Components**		
	Each 11kV circuit breaker cubicle shall be provided with the following minimum standard accessories		
(a)	One control switch ‘trip-neutral-close’ spring return to neutral position		
(b)	One control selector switch ‘Local-Off-Remote stay-put’ type		

Sr. No.	Description	Unit	Technical Particulars
(c)	LED Indicating lamps (i) 'Red' for breaker in 'On' indication (ii) 'Green' for breaker 'Off' position (iii) 'Amber' for breaker tripped on fault 'White' for trip circuit healthy (iv)'Red' for breaker in 'Service' position (v) 'Clear' for breaker in 'Test' position (vi) 'Blue' for breaker spring 'Charged' (vii) 'Amber' for DC fail (viii) 'Amber' for AC fail (ix) 'Red', 'Yellow', 'Blue' for supply healthy for incomers. (x) 'Ready to close'		
(d)	Mechanical trip push button to trip the breaker when control supply is lost. The push button shall be shrouded type		
(e)	One electrical anti-pumping relay		
(f)	Double pole control supply MCB one each for AC&DC control supply Cubicle space heater of adequate capacity with thermostat		
(g)	240V, 1 Phase, 50Hz, 15/5A, 5 pin receptacle with switch		
(h)	Cubicle lamp with door interlock switch		
12.19.14	**Auxiliary A.C. Supply**		
	240V, 1Ph, 50Hz supply shall be made available to each cubicle of 11kV Metal Enclosed Switchboards separately for provision of following by providing control transformer		
(a)	Spring charging motor		
(b)	Cubicle space heater with thermostat		
(c)	Cubicle lamp		
(d)	240V, 1Ph, 50Hz 15/5A 5 pin receptacle with switch		

12.20 Distribution Transformers

Sr. No.	Description	Unit	Technical Particulars
12.20.1	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
12.20.2	Type		As per Specification
12.20.3	Applicable Standards		As per Specification& IS 1180
12.20.4	Rated output	KVA	(*)
12.20.5	Quantity required	Nos.	(*)
12.20.6	Transformer location		Outdoor
12.20.7	No load transformer ratio	kV/kV	11/0.433kV
12.20.8	Number of phases		3

Sr. No.	Description	Unit	Technical Particulars	
12.20.9	Rated frequency	Hz	50	
12.20.10	Impedance at all taps Standard losses	% Watts	Value as per IS 1180. As per IS 1180under revised BEE Star-2 category	
12.20.11	Number of winding / materials of conductor / Insulation class		Two/Copper/class-A	
12.20.12 (a) (b)	Method of connection HV winding LV winding		 Delta Star	
12.20.13	Vector group		Dyn11	
12.20.14	LV Neutral		Solidly earthed	
12.20.15	Type of cooling		ONAN	
12.20.16	Tap changer		Full capacity, microprocessor base On-load type on HV side with local marshalling box and Remote Tap Changing panel	
12.20.17	Tap range	%	+ 5 % to -15 %	
12.20.18	Tap step	%	2.5 %	
12.20.19 (a) (b)	Terminal connection HV terminals LV terminals		 Cable box suitable to 11kVUE,XLPE, Al.Conductor,armoured cable of size (*) Cable box suitable for 1100V XLPE, Al.Conductor armoured cables (*) For transformer ratings greater than or equal to 1000kVA should be suitable for termination of Non-Segregated Aluminium Bus duct (*)	
12.20.20 (a) (b)	Current Transformer On LV On LV Neutral		 (*)	
12.20.21	LV Neutral earthing		LV Neutral shall be brought out through a 1.1kV rated bushing, both inside the cable box for forming the 3Ph, 4-wire system and outside the cable box for direct connections to earth by means of 25 x 3mm, GI earthing conductor (*)	
12.20.22	Insulation of Windings		H.V.	L.V.
(a)	One-minute power frequency withstand voltage (dry and wet)	kV (r.m.s)	28	3.0

Sr. No.	Description	Unit	Technical Particulars	
(b)	1.2/50 micro second full wave impulse withstand voltage	kV (peak)	75	-
12.20.23	Insulation of bushings		H.V.	L.V. (Line and Neutral)
(a)	Rated Voltage of bushing	kV	17.5	1.1
(b)	One-minute power frequency withstand voltage	kV (r.m.s)	38	3.0
(c)	1.2/50 microsecond full wave impulse withstand voltage	kV (peak)	95	-
(d)	Minimum creepage distance	mm	25mm/kV on 17.5kV	25mm/kV on 3kV
12.20.24	Vacuum withstand capability of transformer main tank with bushings, radiations, fitting and accessories.		250mm of mercury upto 200kVA, 500mm of mercury above 200kVA	
12.20.25	Inspection		As per IS 1180, Complete Routine test and one each from Type test and Special test to be indicated in QAP for witness	

12.21 415 V Metal Enclosed Switchgears (PCC) /MCC

Sr. No	Description	Unit	Technical Particulars
12.21.1	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
12.21.2	Type		As per Specification
12.21.3	Applicable Standards		As per Specification
12.21.4	Quantity	No.	(*)
12.21.5	**415 V Switchgear and Busbar Ratings**		
(a)	Rated voltage phase and frequency		415V, 3 Ph, 50 Hz
(b)	System Neutral Earthing		Solidly earthed
(c)	Maximum system voltage	V	476
(d)	One-minute power frequency voltage		
	i) Power circuits	V	2500V (rms)
	ii) Control circuits	V	1500V (rms)

Sr. No	Description		Unit	Technical Particulars
	iii) Aux. Circuits connected to Sec of CTs		V	1500V (rms)
(e)	Continuous current rating of Busbars under site reference Ambient Temperature and type & material		Rating Material	(*) Copper
(f)	Busbar insulation			Fully insulated encapsulation in epoxy resin with moulded caps protecting all joints
(g)	Reference Ambient Temperature		^{o} C	45
(h)	Maximum Temperature of Busbars, Droppers and Contacts at Continuous current rating under site ambient temperature		^{o} C	85^{o} C for busbarsand non-silver-plated joints 100^{o} C for silver plated joints
(i)	Short Circuit current withstand for Busbars and droppers (i) Short time 1 sec		kA (rms)	50
	(ii) Dynamic Rating		kA (peak)	125
12.21.6	**Switchgear Constructional Requirement**			
(a)	Type of Construction			Single front fixed type (Except for air Circuit Breakers, which shall be drawout type). Construction features shall be as per specification.
(b)	Thickness of sheet steel (i) Frame, Frame enclosures, doors, covers and partitions		mm	CRCA– 2.0
(c)	Degree of protection			IP 54 indoor and IP65 for outdoor
(d)	Colour finish shade			Interior: Glossy white
				Exterior: Light grey semi glossyShade 631 of IS-5
(e)	Earthing bus	Material		Copper(run throughout the panel)
		Size	mm x mm	(*)
(f)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(g)	Minimum clearances in air of live parts			

Sr. No	Description	Unit	Technical Particulars
	(i) Phase to Phase	mm	25.4
	(ii) Phase to Earth	mm	25.4
(h)	(i) Cable entry (ii) Cable entry for panels above wet well		Bottom Top
12.21.7	**Instrumentation Transformers**		
(a)	Current transformer		
	(i) Ratio		(*)
	(ii) Burden	VA	(*)
	(iii) Accuracy Class		1.0
(b)	Voltage transformer		
	(i) Ratio		(415V/√3)/ (110V/√3)
	(ii) Burden	VA	50
	(iii) Accuracy Class		1.0
(c)	Auxiliary A.C. Supply		240V, 1Ph, 50Hz supply shall be made available to each cubicle of 415V Metal Enclosed Switchboards separately by providing control transformer

12.22 Power Capacitor and Control Panel

Sr. No	Description	Unit	Technical Particulars
12.22.1	**General**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Type		As per Specification
(c)	Applicable Standards		As per Specification
(d)	Quantity	No.	(*)
(e)	Rated Capacity	KVAR	(*)
(f)	Rated supply voltage	V	415
(g)	Rated frequency and phases		50Hz, 3Phase
(h)	Reference Ambient temperature	^{o} C	45
(i)	Cable gland required		Yes
(j)	Type of cable		1.1kV, XLPE, Al. Conductor

Sr. No	Description		Unit	Technical Particulars
(k)	Size of cable			(*)
(l)	Cable entry			Bottom
12.22.2	**Constructional Requirement**			
(a)	Thickness of sheet steel i) Frame, Frame enclosures, doors cover and partition		mm	CRCA 2.0
(b)	Degree of protection			IP 42
(c)	Colour finish shade			Interior: Glossy white
				Exterior: Light Grey Semi GlossyShade 631 of IS-5
(d)	Main busbars and size			Copper and (*)
(e)	Maximum Temperature of Busbars, Droppers and Contacts at Continuous current rating under site ambient temperature		^{o} C	85^{o} C for busbarsand non-silver-plated joints 100^{o} C for non-silver-plated joints
(f)	Earthing bus	Material		Copper(run throughout the panel)
		Size	mm x mm	(*)
(g)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
12.22.3	**Design Requirement**			
(a)	Insulation level		kV (rms)	3.0
(b)	Capacitor bank connection			Delta
(c)	Short circuit withstand for busbars i) Short time (1 sec)		kA (rms)	50
	ii) Dynamic		kA (peak)	125
(d)	Type of switching			Automatic switching responsive to power factor through power factor sensing relay
(e)	Switching steps			Minimum 8 steps
(f)	Switch and Rating of contactor			To suit KVAR of unit(switching duty)
(g)	Incomer MCCB current rating			To suit rated capacity of capacitor banks (switching duty)

Sr. No	Description	Unit	Technical Particulars
(h)	O/L capacity of capacitors		30% of rated capacity as per IS
(i)	O/V capacity of capacitors		10% of rated voltage as per IS
(j)	Protections		O/V, U/V and O/L

12.23 Diesel Standby Generator Sets

Sr. No.	Description	Unit	Technical Particulars
12.23.1	**General**		
(a)	Set Manufacturer		
(b)	Type		Silent Set with AMF
(c)	Sound Level at 1 metre distance		< 75 dB
12.23.2	**Alternator**		
(a)	Manufacturer		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Type		Salient pole, Revolving field, Brushless type
(c)	Rating	KVA	(*)
(d)	Voltage	V	415
(e)	Frequency	Hz	50
(f)	Overload Capacity		10% overload for 1 hour in any 12 hours
(g)	Insulation		Class H with Class F temperature rise
(h)	Short circuit current		3 times full load current for 10 sec
(i)	Degree of protection		IP 23 with IP 54 for terminal box
(j)	Current	A	(*)
(k)	Power Factor		0.8
12.23.3	**Diesel Engine**		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(a)	Manufacturer		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Type		Four stroke, direct injection,turbocharged
(c)	Rating	KW	(*)
(c)	Speed	rpm	1500
(d)	Fuel Specification		As per manufacturer's standard
(e)	Overload Capacity		10% overload for 1 hour in any 12 hours
(f)	Class of governance		Class A2
12.23.4	Day oil tank capacity with all necessary connections for fuel flow from day tank to DG engine with level sensors, inlet, outlet	Litres	990 (DG Set rating less than 200kVA fuel storage shall require to run

Sr. No.	Description	Unit	Technical Particulars
	piping with valves and accessories etc. Complete		minimum 10 hours continuously)

12.24 Variable Frequency Drives

Sr. No.	Description	Unit	Technical Particulars
12.24.1	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
12.24.2	Type of Drive		Inverter Controlled A.C Drives
12.24.3	Rated voltage, frequency and phases		415V, 50Hz, 3Phase
12.24.4	Variation in voltage		415V $\pm$ 10
12.24.5	Variation in frequency		50Hz $\pm$ 5
12.24.6	Type of Duty		100% continuous, 150 % overload for 2 minutes once in period of 24 hours, 200 % overload for 10 seconds once in period of 24 hours
12.24.7	Design Ambient Temperature		45^0C
12.24.8	Overall Harmonic Limitation (THDi)		Less than 5% (including current and voltage harmonics)
12.24.9	Application		As per Clause 12.14.4ofPart12– Particular Electrical Plant Requirements
12.24.9.1	Interfaces		Serial /Profibus

12.25 Battery

Sr. No.	Description	Unit	Technical Particulars
12.25.1	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
12.25.2	Type of battery		Ni-Cd
12.25.3	Applicable Standards		As per Specification
12.25.4	Number of battery banks required		(*)
12.25.5	Ambient conditions		Min. Temp. 25° C
			Max. Temp 45° C
12.25.6	D.C. system voltage	V	110 ±10%

12.25.7	Ampere hour capacity of battery at 27 Deg. C at 5-hour rate to give final cell voltage of 1.16 volts/cell	Ah	As per the Requirement
12.25.8	Momentary load/duration	A	To be furnished by the Bidder
12.25.9	Emergency load/duration	A	
12.25.10	Continuous load/duration	A	
12.25.11	Nominal voltage	V	1.2 V per cell
12.25.12	Cell voltage - initial/final	V	1.42/1.14 V
12.25.13	Number of cells per bankrequired to give rated voltage	Nos	(*)
12.25.14	Number of spare cells per bank	Nos	(*)
12.25.15	Mounting arrangement		Multi tier
12.25.16	Charging method		Float cum boost charging

12.26 Battery Charger

Sr. No.	Description	Unit	Technical Particulars
12.26.1	**General**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Applicable Standards		As per Specification
(c)	Type		Float and Float cum Boost Charge
(d)	Number required	Nos	(*)
(e)	Rated Output voltage (DC)	V	110
(f)	Rated Output	kW	(*)
(g)	DC System Earthing		Unearthed
(h)	Voltage regulation from no load to rated load	%	± 1
(i)	Ambient Design Temperature	Deg C	45
(j)	**AC ripple in DC output voltage at rated continuous load**		Less than 1%
(k)	**Type of rectifier**		SCR, full wave fully controlled
(l)	**Transformer**		Copper double wound dry type with class-F insulation
(m)	Float/Trickle charging current of battery	mA	As per manufacturer
(n)	Boost Charging Current of Battery	A	As per manufacturer

Sr. No.	Description		Unit	Technical Particulars
	(Maximum)			
(o)	Boost Charging Voltage of Battery (maximum)		V	As per manufacturer
(p)	Maximum Time for Boost charging of Battery		hr	As per manufacturer
12.26.2	**Battery Details**			
(a)	Float/Trickle charging current of battery		mA	As per manufacturer
(b)	Boost Charging Current of Battery (Maximum)		A	As per manufacturer
(c)	Boost Charging Voltage of Battery (maximum)		V	As per manufacturer
(d)	Maximum Time for Boost charging of Battery		hr	As per manufacturer
(e)	Battery capacity & no. of cells		Ah	(*)
			Nos.	(*)
12.26.3	**AC System Data**			
(a)	Supply	Voltage	V	415
		Phase		3
(b)	(i) Variation in supply Voltage		%	± 10
	(ii) Variation in supply frequency		%	± 5
(c)	Short Circuit level		kA	50
(d)	Type of earthing			Solidly Earthed
12.26.4	**Performance**			
(a)	DC voltage setting adjustment for float charger			±10% of nominal voltage
(b)	Voltage stabilisation for constant voltage regulator			±1% of set D.C. voltage, with AC input variation and DC load variation from 0 to 100%
(c)	Maximum permissible variation in DC voltage (no load to full load)			± 1%
(d)	D.C. voltage setting adjustment for boost charging			70% to 100% of max. boost charging voltage
(e)	D.C. current adjustment for boost Charging			30% to 100% of max. boost charging current
(f)	Current stabilisation for constant current regulator for boost charger			± 2%
(g)	Minimum permissible power factor to rated continuous load			0.8
(h)	Permissible ripple content at rated continuous load			3% (maximum)

Sr. No.	Description		Unit	Technical Particulars
(i)	Relay for auto changeover fromFloat to boost mode to be provided(in case of float-cum-boost charger)			Yes
12.26.5	**Constructional Features**			
(a)	Thickness of sheet steelFrame, Frameenclosures, doors, covers and partition		mm	Cold rolled 2.0
(b)	Degree of protection			IP 42
(c)	Colour finish shade			Interior: Glossy white
				Exterior: Light Grey Semi Glossy Shade 631 of IS 5
(d)	Earthing bus	Material		Copper
		Size	mm x mm	(*)
(e)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(f)	Cable entry			Bottom
(g)	Cable Sizes (i) Battery		sq.mm	(*)
	(ii) DC output		sq.mm	(*)
	(iii) AC input		sq.mm	(*)

12.27 DC Distribution Board

Sr. No.	Description	Unit	Technical Particulars
12.27.1	**General**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Applicable standards		As per specification
(c)	Quantity	Nos	(*)
(d)	DC System voltage (Nominal)	V	110
(e)	DC System Earthing		Unearthed
(f)	Ambient Design Temperature	Deg. C	45° C
(g)	Busbarmaterial, rating and size		Copper, Rating & Size (*)
12.27.2	**DC Bus Load**		
(a)	Total continuous DC load	A	(*)

(b)	Short time loads (Additional to continuous loads)			
	(i) DC lights/Facia lamps		A	(*)
	(ii) Starting current and durationof Largest Connected DC Motor		A	(*)
			Secs	(*)
12.27.3	**Constructional Features**			
(a)	Thickness of sheet steelFrame, Frame enclosures, doors, covers and partition		mm	CRCA 2.0 min.
(b)	Degree of protection			IP 54
(c)	Colour finish shade			Interior: Glossy white
				Exterior: Light Grey Semi Glossy Shade 631 of IS 5
(d)	Earthing bus	Material		Copper(run throughout the panel)
		Size	mm x mm	(*)
(e)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(f)	Cable entry			Bottom
(g)	Cable Sizes (i) DC Input from Battery		sq.mm	(*)
	(ii) DC output to Load		sq.mm	(*)

12.28 Cables

Sr. No.	Description	Unit	Technical Particulars
12.28.1	**11kV (UE) XLPE Insulated Power Cables**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Applicable Standards		As per specification
(c)	Cable size selection		As per requirement
(d)	Continuous current rating with cable laid in air/ ground under specified ambient temperature	A	(*)
(e)	Conductor material		Stranded, aluminium, EC grade/class-2
(f)	Conductor screening		Semiconducting compound by extrusion
(g)	Insulation		Extruded XLPE
(h)	Screening on Insulation		Semiconducting compound by extrusion (non-metallic), copper

Sr. No.	Description	Unit	Technical Particulars
			tape (metallic)
(i)	Identification of codes		By providing strip of Red, Yellow & Blue colours
(j)	Inner sheath		Extruded PVC, type ST-2
(k)	Filler material		PVC
(l)	Armouring		Galvanised steel flat strip
(m)	Outer sheath		Extruded PVC, type ST-2
(n)	Overall diameter of cable		To be furnished by the Bidder
(o)	Recommended minimum bending radius	mm	To be furnished by the bidder
(p)	Standard length of cable on each drum	mts	(*)
12.28.2	**1100V Grade XLPE Insulated Power Cables**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Applicable Standards		As per specification requirement
(c)	Cable size selection		As per specification
(d)	Conductor material		Stranded, aluminium/copper, EC grade
(e)	Insulation		XLPE
(f)	Inner sheath		Extruded PVC, type ST-2
(g)	Armouring		Galvanised steel flat strip/round wire
(h)	Outer sheath		Extruded PVC, type ST-2
(i)	Overall diameter of cable		To be furnished by the Bidder
(j)	Recommended minimum bending radius	mm	To be furnished by the bidder
(k)	Standard length of cable on each drum	mts	(*)
12.28.3	**650/1100V Grade PVC Insulated Control Cables**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement
(b)	Applicable Standards		As per specification
(c)	Rated voltage	V	As per requirement
(d)	Cable size selection		As per specifications requirement
(e)	Conductor material		Stranded, copper, EC grade
(f)	Insulation		PVC
(g)	Inner sheath		Extruded PVC, type ST-1
(h)	Armouring		Galvanised steel round wire
(i)	Outer sheath		Extruded PVC, type ST-1

Sr. No.	Description	Unit	Technical Particulars
(j)	Standard length of cable on each drum	mts	(*)

12.29 Lighting Fixtures and Accessories

Sr. No.	Description	Unit	Technical Particulars
12.29.1	**General**		
(a)	Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
(b)	Type		As per specification
(c)	Illumination levels at various premises		As per Building Services, Clause 12.16of Part 12-Particular electrical requirements
(d)	Normal supply voltage, phase and frequency	AC	240V, 1Ph, 2 wire, 50Hz
		DC	110V, 2 wire, unearthed
(e)	Variation in supply:		
	(i) Voltage (AC & DC)	%	$\pm$ 10
	(ii) Frequency	%	$\pm$ 5
	(iii) Combined voltage & frequency	%	$\pm$ 10
(f)	Design ambient air temperature	^{0}C	45° C
12.29.2	Luminaire terminal suitable for		
(a)	Indoor area		
	(i) Conductor material		Copper
	(ii) Cable size	Coresxmm^2	(*)
(b)	Outdoor area		
	(i) Conductor material		Copper
	(ii) Cable size	Cores xmm^2	(*)
12.29.3	Luminary earthing terminal suitable for		
	(i) Conductor material		G. S. wire
	(ii) Conductor size	SWG	(*)

12.30 Lighting System and Equipment

Sr.No.	Description	Unit	Technical Particulars
12.30.1	**System Particular**		
(a)	**Voltage**		
	(i) 3 Phase, 4 wire 50 Hz system		
	• Rated	V	415
	• Maximum	V	476
	• One minute withstand voltage		3000 V AC.
	(ii) D.C. system		
	• Rated	V	110
(b)	System short-circuit level		
	(i) At 415 V, A.C.	kA (rms)	10
	(ii) At 110 V.D.C.	kA (D.C.)	6
(c)	Reference ambient temperature	^{0} C	45^0 C
12.30.2	**Distribution Board/Panels**		
(a)	Main, floor mounted distribution boards		
(i)	Main Lighting distribution board (A.C.)		
	• Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
	• Type		Floor standing, sheet steel Enclosed
	• Degree of protection		IP 54
	• Busbar material		Copper
	• Busbar current rating	A	(*)
	• Short circuit current rating	kA	(*)
	• Cable entry		Based on Layout Top or bottom
	• Location		Indoor
(ii)	Emergency lighting panel (D.C.)		
	• Make		As per Preferred Makes/Manufacturers of Part-6,

Sr.No.	Description	Unit	Technical Particulars
			General requirement.
	• Type		Wall mounting, sheet steel Enclosed
	• Degree of protection		IP 54
	• Busbar material		Copper
	• Busbar current rating	A	(*)
	• Short circuit current rating	kA	(*)
	• Cable entry		Based on Layout Top or bottom
	• Location		Indoor
(iii)	Single phase DBs, wall/structure mounting		
	SLDB for indoor area		
	• Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
	• Type		Wall mounting, sheet steel enclosed
	• Degree of Protection		IP 54
(iv)	SLDB for outdoor area		
	• Make		As per Preferred Makes/Manufacturers of Part-6, General requirement.
	• Type		Wall mounting, sheet steel enclosed
	• Degree of Protection		IP 65
(v)	Paint Finish		
	(i) Colour shade:		Interior: Glossy white
			Exterior: Light gray semi glossy shade 631 of IS:5
12.30.3 (a)	**Street Light Poles and Flood Light Poles** Street Light Pole single arm		
	Total Height:	m	7.5
	Quantity:	Nos.	(*)
(b)	Floodlight Light Pole		

Sr.No.	Description	Unit	Technical Particulars
	Total height:	mts.	9
	No. Of floodlights to be fixed per pole	No.	(*)

12.31 Earthing and Lightning Protection System

Sr. No.	Description	Technical Particulars		
		Size	**Material**	**No. of Leads& Quantity**
12.31.1 (a)	**Main Earthing Grid** Buried in earth	(*)	MS	Quantity as per requirement
(b)	Buried in floor slabs in buildings	(*)	MS	Quantity as per requirement
12.31.2	**Conductor Leads to Equipment** (above ground)			Number of Leads As per relevant Standards, Quantity as per requirements
(a)	Transformers			
(i)	Transformer neutral to bottom of tank	(*)	GS	
(ii)	From bottom of tank to earth grid	(*)	GS	
(iii)	Transformer tanks and radiator bank	(*)	(GS	
(b)	Diesel Generator Set			
(i)	DG Set neutral earthing	(*)	GS	
(ii)	DG Set body earthing	(*)	GS	
(c)	Fence posts and gates (Flex. braid)	(*)	GS	
12.31.3	11kVMetal Enclosed Switchboard,415Vswitchgear/ MCC.	(*)	GS	
12.31.4	Motors			
(a)	415V Motors above 10 kW	(*)	GS	
(b)	415V Motors up to 10 kW	(*)	GS	
(c)	Fractional horse power motors	(*)	GS	
12.31.5	**Other Items**			
(a)	Capacitor panel, Battery charger panel, DC distribution board,Main lighting D.B, Control panels and sub-lighting distribution boards	(*)	GS	
(b)	Hand Rails	(*)	GS	
(c)	Cable trays	(*)	GS	
(d)	Tanks	(*)	GS	
(e)	Junction boxes	(*)	GSwire	
(f)	Lighting fixtures, receptacles, lighting conduits	(*)	GSwire	
(g)	Push button stations, limit	(*)	GSwire	

Sr. No.	Description	Technical Particulars		
	switches			
12.31.6	**Crane rail**	(*)	GS	
12.31.7	Street lighting, flood lighting poles and junctions' boxes	(*)	GS	
12.31.8	Metallic non-current carrying structures	(*)	GS	
12.31.9	**Lightning Conductors**			
(a)	Lightning protection down comers for building	(*)	GS	
(b)	Lightning protection horizontal roof conductor for building	(*)	GS	
9.31.10	**Electrodes**	(*)	Heavy duty 40mm diameterGI pipe 3000 mm long	Quantity as per requirements
(a)	Pipe electrode	(*)		

Note: Any requirement /features /provisions not specifically mentioned in the Specification but are necessary for trouble free and smooth operation of the Plant System shall be included.

(i) (*) – The numbers, ratings, sizes etc shall be worked out by the contractor during execution and to be approved by the Engineer.

(ii) Contractor shall notify the Employer for factory inspection and testing of equipment as defined in Clause 14.1.2,Materials, Plant &Equipment of Part 14, Volume -2 of the Bid document.

End of Part-12